TRI-PARTY AGREEMENT

Change Notice Number TPA-CN- 659	TPA CHANGE NOTICE FORM	Date: 9/3/15
Document Number, Title, and Revision: DOE/RL-2012-45, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Replacement Wells*		Date Document Last Issued: November 2012
Originator: Kris Ivarson		Phone: 376-1941

Description of Change:

Modification of well locations for replacement wells at 100-D and 100-H. Adds one well. Soil sampling is also added to the SAP.

R.J. Corey (**DOE**) and N. Menard/C. Guzzetti (**Lead Regulatory Agency**) agree that the proposed change modifies an approved work plan/ document and will be processed in accordance with the Tri-Party Agreement Action Plan, Section 9.0, *Documentation and Records,* and not Chapter 12.0, *Changes to the Agreement*.

The document is modified throughout to incorporate changes for the replacement wells, adding a well and to add soil sampling to the SAP. An additional change to Table 2-3 is being made to correct a holding time that was incorrect in the original document.

Note: Added text is denoted by double underline. Deleted text is denoted by ~~strike-through.~~
Affected pages 1-1, 1-3 through 1-8, New pages 1-9 through 1-14, 2-6 through 2-8, 2-10 through 2-13, 3-1, 3-2, 3-3, 3-5, and 3-7 through 3-12.

Justification and Impacts of Change:

The Sampling and Analysis Plan (SAP) for Installation of 100-HR-3 Groundwater Operable Unit Replacement Wells (DOE/RL-2012-45, Rev. 0) was approved in 2012. The SAP was prepared for the installation of wells in the 100-D and 100-H Areas to replace wells that were to be decommissioned in support of waste site excavation. In 2012, a total of 13 wells were planned on being replaced, based on the anticipated extent of the excavations. Ultimately, only six of the 13 replacement wells were installed in 2013: 199-H4-86, 199-H4-85, 199-D5-145, 199-D5-146, 199-D5-147 and 199-D5-148.

During remediation activities, persistent contamination levels were identified at 100-D-100. The investigation identified contamination along two edges of the excavation, along the periodically rewetted zone. One area is located along the northeast corner of the excavation area, where waste site 100-D-56 (sodium dichromate supply pipeline) intersects the 100-D-100 waste site excavation footprint. Additional excavation along that sidewall was not feasible due to safety considerations. A second area is located on the western sidewall. A bench in the excavation was present in this area with noticeable chromium discoloration within 10 feet of the water table. The bench and sidewall were excavated to the extent practicable. Additional contamination may be present farther west, within the sidewall and beyond the extent of removal.

In response to the information gained during the waste site excavation activities, several replacement well locations are to be moved and/or soil sampling is being added, as described below.

- Replacement Well 199-D5-150 is to be moved to the east side of the 100-D-100 excavation, and align with the location of decommissioned Well 199-D5-121. This addresses the potential contamination remaining in the vadose zone along the north-eastern sidewall of the excavation.
- Replacement Well 199-D5-151 is to be moved to the west side of the 100-D-100 excavation. The location addresses the potential for remaining contamination in the vadose zone along the western sidewall of the excavation.

- Vadose zone sampling (Table 1-3) is added for wells 199-D5-149, 199-D5-151, and 199-D5-152. The wells are to be placed within an area of suspected contamination within the periodically rewetted zone and aquifer, based on the results of the 100-D-100 excavation sampling.

- Replacement Well 199-H4-88 is to be moved to a location upgradient of the 183-H solar evaporation basin #1. This will assist in determining the extent of the remaining hexavalent chromium plume in that area. Vadose zone sampling (Table 1-3) has been added to determine if contamination is present in the periodically rewetted zone. The addition of soil sampling at Well 199-H4-88 is directly related to moving the well to within the footprint of the excavation. Based on groundwater sampling data and historical information, contamination remains in the vadose zone at the 183-H solar evaporation basins. The magnitude of the contamination remaining has not yet been determined along the western side of the waste site.

- Replacement Well 199-H4-87 is to be moved to a location within the 100-H-46 excavation area. The well will be placed downgradient of where the highest hexavalent chromium concentrations were identified during the waste site remediation. Vadose zone sampling (Table 1-3) has been added to determine if contamination is present in the periodically rewetted zone. Soil sampling was added to Well 199-H4-87 based on its location within the excavation footprint and high levels of contamination in the immediate vicinity. The magnitude of the contamination remaining has not yet been determined at the waste site.

- There is no change to the location of sampling proposed for Well 199-H4-89. The well is located outside the footprint of the excavation area and soil contamination is not expected in this area.

Drilling will target the period of low river stage to meet the data quality objective of characterizing Cr(VI) in the vadose zone immediately above the periodically rewetted zone, through the rewetted zone and 10 ft into the water table. Data is to be collected to a depth consistent with the prior excavation boreholes during low river stage, as specified in the document.

NOTE: Table 1-1 headers are being changed to include the year the well installations are planned.

Approvals:

J C Pyzong FOR DOE Project Manager	9·15·15 Date	[X] Approved [ ] Disapproved
[signature] EPA Project Manager	9/15/15 Date	[X] Approved [ ] Disapproved
Nina M. Menard Ecology Project Manager	9/16/15 Date	[X] Approved [ ] Disapproved

1 Introduction

This sampling and analysis plan (SAP) has been prepared for the installation of wells in the 100-D and 100-H Areas to replace wells that ~~are~~ were being decommissioned to support source area remediation. This SAP directs the collection of aquifer and vadose sediment and groundwater data. Aquifer sediment samples will facilitate well design. Groundwater and vadose data will be used to confirm ambient chemical concentrations

The 100-D and 100-H Areas are within the geographic boundary of the 100-HR-3 Operable Unit (OU), which underlies the top, northwest bend of the Columbia River in the 100 Area of the Hanford Site (Figure 1-1). The 100-HR-3 OU contains the 100-D and 100-H Area hexavalent chromium plumes and associated vadose zone sources. Remediation of vadose zone sources is ongoing using Remove, Treat, and Dispose technology and active groundwater remediation is being implemented through ion exchange pump-and-treat technology using the DX and HX pump-and-treat systems and the in situ redox manipulation (ISRM) barrier in 100-D. Together, these actions constitute the integrated interim source and groundwater remedies applied to the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source area OUs, and the 100-HR-3 groundwater OU (EPA/ROD/R10-96/134, EPA/AMD/R10-97/044, EPA/ROD/R10-99/039, EPA/ROD/R10-00/121, and EPA/AMD/R10-00/122).

The 13 replacement wells are listed in Table 1-1. Six of these wells ~~are pending replacement (projected for fiscal year 2013), one is in near term replacement (projected for fiscal year 2014),~~ have been installed, and the remaining ~~six~~ wells are scheduled to be replaced in Fiscal Year 2016, ~~an out year~~ after the source area remediation is complete and the excavated areas are backfilled. The locations of the ~~pending~~ now installed replacement wells are shown as yellow dots in Figures 1-2 and 1-3. The remaining replacement wells are shown as orange and magenta dots in Figures 1-2 and 1-3. The schedule for well replacement is based on the evaluation of site priorities and available funding.

A systematic planning process was used to identify data needs for well installation. The project team members attended a planning meeting on September 6, 2012, and finalized the data needs. The planning process identified the type, quantity, and quality of data that will be appropriate for the intended use and to support the sample design presented in this SAP.

Aquifer sediments will be collected during borehole installation to determine screen size and filter pack. A groundwater sample will be collected after well development and analyzed for a subset of 100-HR-3 OU groundwater monitoring analytes (Table 1-2). These samples and groundwater samples collected after well acceptance are identified in the Field Sampling Plan (Chapter 3 of this report). In addition, three water samples will be collected from each well planned in the 100-D Area during drilling to evaluate the vertical distribution of hexavalent chromium, as listed in Table 1-3.

Vadose zone soil samples will be collected during drilling at Well 199-D5-149, 199-D5-150, 199-D5-151, 199-D5-152, 199-H4-87, and 199-H4-88 to determine if contamination remains in the periodically rewetted zone. Soil samples for wells in 100-D Area will be analyzed for the constituents listed in Table 1-4. Soil samples for wells in 100-H Area will be analyzed for constituents listed in Table 1-5. Figures 1-4, 1-5 and 1-6 present the geology and estimated sample depths for each well in 100-D. Depths are adjusted to reflect the modified ground surface. Figures 1-7 and 1-8 present the geology and estimated sample depths for wells in 100-H. Ground surface elevations have not been surveyed, and therefore the figures represent conditions prior to excavation and backfill of the area.

Schedule of drilling and completion activities will be coordinated between the source remediation team and the drilling and sampling team, but will target a period of low river stage.

Table 1-1. Replacement Monitoring Wells in 100-HR-3

Replacement Well Name and Borehole ID	Replacement Well Easting*	Replacement Well Northing*	Historical Purpose	Replacing Well	Easting*	Northing*	Comment
~~Pending Wells for Installation~~ Installed Wells							
199-H4-86 (C8724)	577705.05	152736.21	Injection	199-H4-14	577803.7	152752.4	Relocate injection well to the west away from excavation.
199-H4-85 (C8723)	577980.04	152880.67	RCRA monitoring ~~(Non-WAC compliant)~~	199-H4-3 (Non-WAC compliant)	577940.5	152858.5	Relocate to provide downgradient monitoring for RCRA sampling.
199-D5-145 (C8725)	573215.53	151396.22	D-South plume monitoring	199-D5-102	573428.2	151340.2	Relocate to provide downgradient monitoring of 100-D-100 area.
199-D5-146 (C8726)	573219.75	151345.63	D-South plume monitoring	199-D5-121	573430.2	151399.3	Relocate to provide downgradient monitoring of 100-D-100 area north of 100-D-50:7.
199-D5-147 (C8727)	572993.32	151380.77	D-South plume monitoring	199-D5-119	573306.2	151418.0	Relocate to provide downgradient monitoring of 100-D-100 area.
199-D5-148 (C8728)	573361.55	151083.22	D-South plume monitoring	199-D5-98	573369.6	151272.4	Relocate to provide monitoring of 100-D-100 area and potential location for future injection.

Table 1-1. Replacement Monitoring Wells in 100-HR-3

Replacement Well Name and Borehole ID	Replacement Well Easting*	Replacement Well Northing*	Historical Purpose	Replacing Well	Easting*	Northing*	Comment
Near Term Replacement Well – Planned for 2016							
199-D5-149 (C8729)	573327.7	151461.8	D-South plume monitoring	199-D5-120	573377.2	151406.8	Relocate to area south of 183-D clearwells to provide downgradient monitoring of the northern portion of 100-D-100.
Out-Year Replacement Wells – Planned for 2016							
199-D5-150 (C8730)	~~573150.0~~ 573428.94	~~151513.9~~ 151402.06	RI/FS characterization/ monitoring	199-D5-144	573352.0	151404.8	Relocate after backfilling 100-D-100 along northeast upgradient edge of the 100-D-100 site. Align with former Well 199-D5-121.
199-D5-151 (C8731)	~~573349.6~~ 573312.0	~~151402.0~~ 151392.0	D-South plume monitoring	199-D5-99	573349.6	151402.0	~~Replace at current location on the north side of the 100-D-100 footprint.~~ Relocate to the west of original location.
199-D5-152 (C8732)	573300.3	151349.3	D-South plume monitoring	199-D5-122	573300.3	151349.3	Replace at current location on the east side of the 100-D-100 footprint to provide monitoring at the "former" hotspot.

Table 1-1. Replacement Monitoring Wells in 100-HR-3

Replacement Well Name and Borehole ID	Replacement Well Easting*	Replacement Well Northing*	Historical Purpose	Replacing Well	Easting*	Northing*	Comment
199-H4-87 (C8733)	~~577792.7~~ 577732.3	~~152620.2~~ 152660.0	Monitoring	199-H4-48	577792.7	152620.2	~~Replace at current location.~~ Replace downgradient of highest contamination identified during 100-H-46 waste site remediation.
199-H4-88 (C8734)	~~577804.1~~ 577850.4	~~152890.8~~ 152833.6	~~WAC compliant CERCLA m~~ Monitoring	199-H4-7	577804.1	152890.8	~~Replace in current location.~~ Replace to the south of current location.
199-H4-89 (C8735)	577923.2	152893.9	~~WAC compliant CERCLA m~~ Monitoring	199-H4-9	577923.2	152893.9	Replace in current location next to 183-H Solar Evaporation Basins.

* Coordinate system is NAD83(91) in meters.

WAC = *Washington Administrative Code*

CERCLA = Comprehensive *Environmental Response, Compensation, and Liability Act of 1980*

RCRA = *Resource* Conservation *and Recovery Act of 1976*

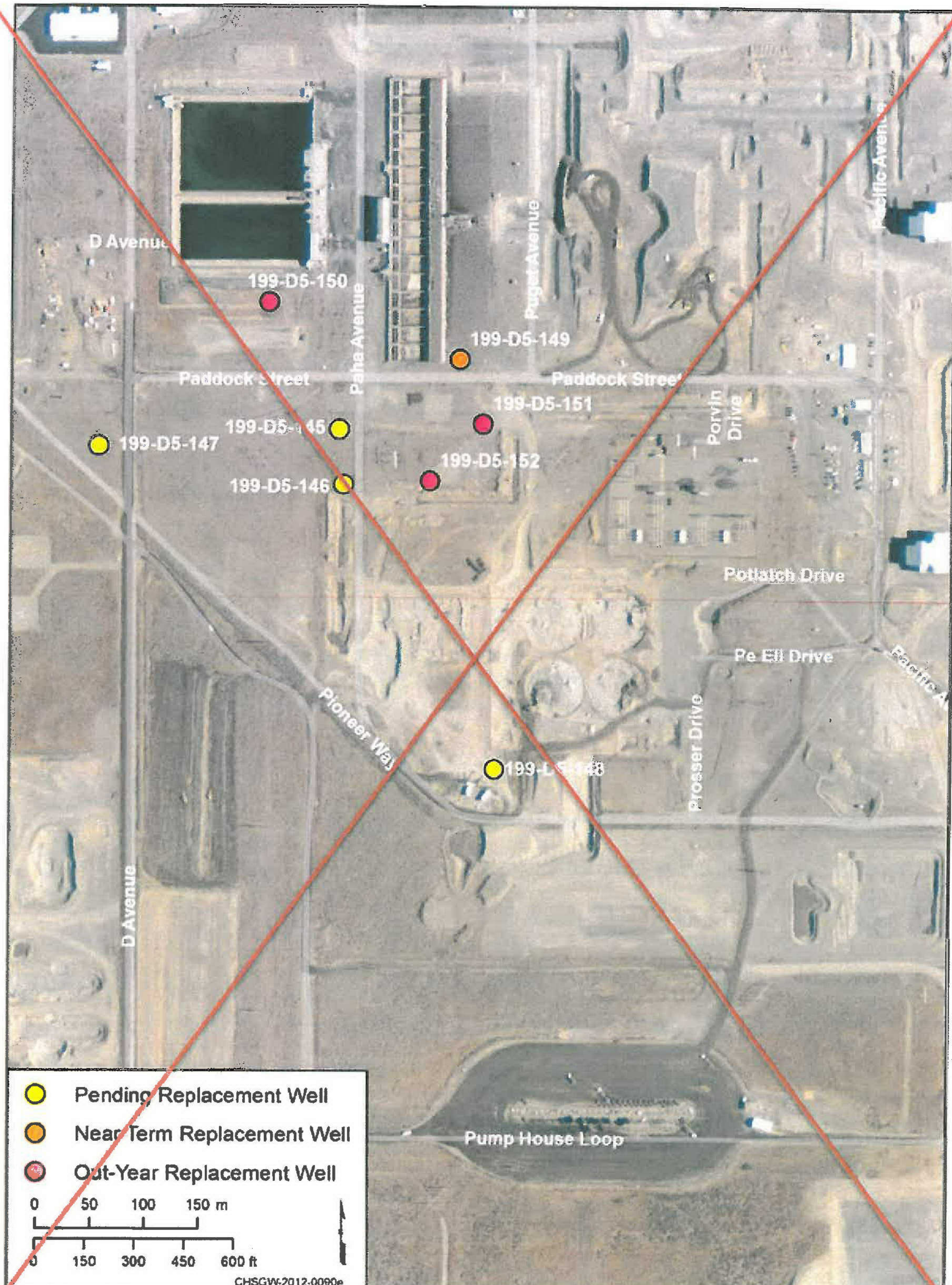


Figure 1-2. Location of 100-D Area Replacement Wells

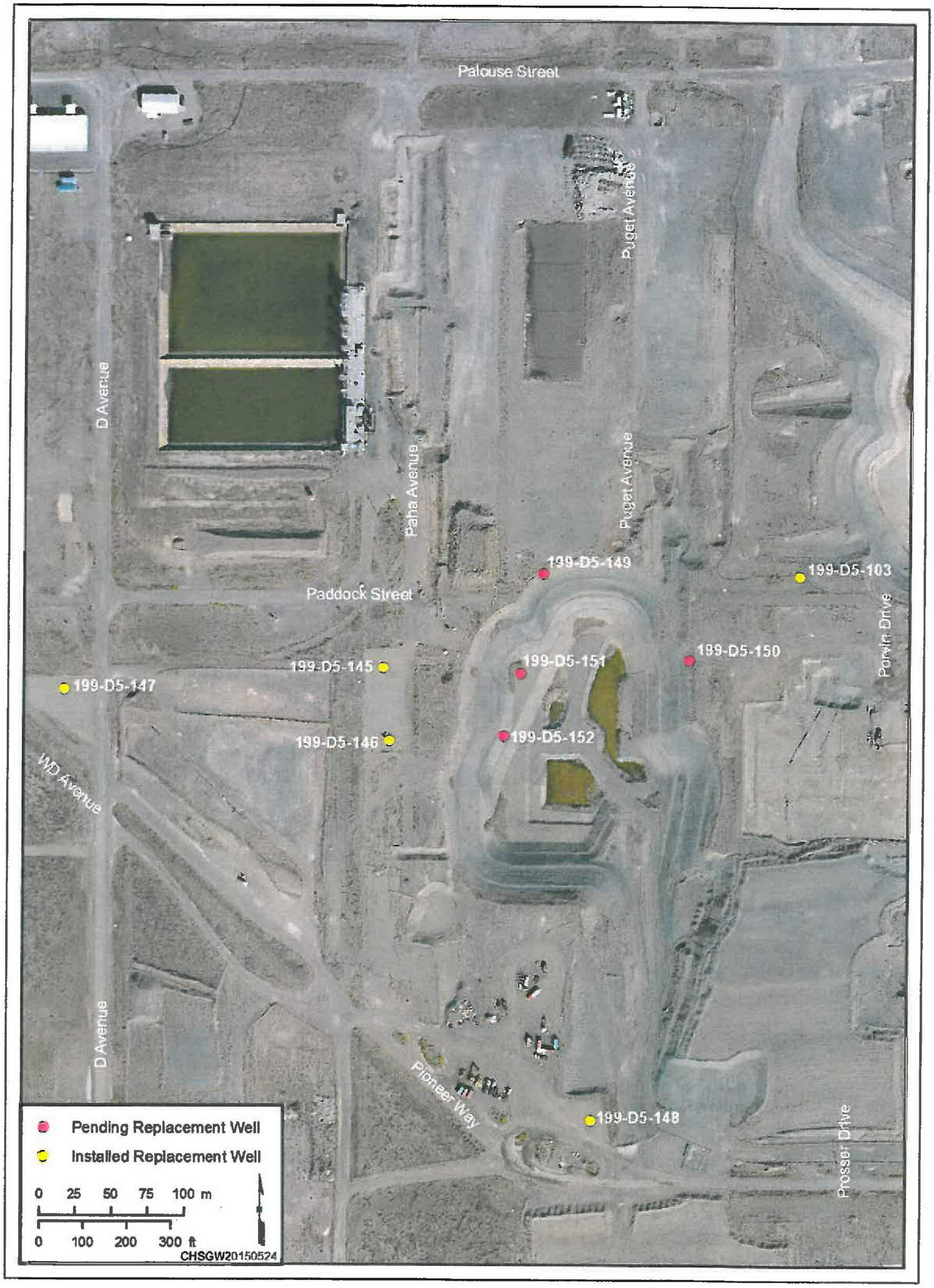


Figure 1-2. Location of 100-D Area Replacement Wells

Figure 1-3. Location of 100-H Area Replacement Wells

Figure 1-3. Location of 100-H Area Replacement Wells

Table 1-2. Groundwater Sampling Analytes

Anions	Metals		Radionuclides
Chloride	Antimony	Magnesium	Strontium-90
Fluoride	Barium	Manganese	Total alpha
Nitrate	Beryllium	Potassium	Total beta
Nitrite	Cadmium	Nickel	
Sulfate	Chromium (hexavalent)*	Sodium	
	Chromium (total) filtered	Silver	**Other**
	Copper	Strontium	Alkalinity
Field Parameters	Cobalt	Vanadium	
pH	Iron	Zinc	
Dissolved Oxygen			
Specific Conductivity			
Temperature			
Turbidity			

* Analyzed immediately after well development as a filtered sample.

Table 1-3 Groundwater Sampling During Drilling

Well Numbers	Analytes	Approximate Sample Depth below Water Table
199-D5-149	Chromium (hexavalent)	1.5 m (5ft); 4.5 m (15 ft); 6.7 m (22 ft)
199-D5-150	Chromium (hexavalent)	1.5 m (5ft); 4.5 m (15 ft); 6.7 m (22 ft)
199-D5-151	Chromium (hexavalent)	1.5 m (5ft); 4.5 m (15 ft); 6.7 m (22 ft)
199-D5-152	Chromium (hexavalent)	1.5 m (5ft); 4.5 m (15 ft); 6.7 m (22 ft)
Note: Sample to be collected using field sampling equipment		

Table 1-4. Soil Sampling Analytes (100-D)

Metals	
Antimony	Magnesium
Barium	Manganese
Beryllium	Potassium
Cadmium	Nickel
Chromium (hexavalent)	Sodium
Chromium (total)	Silver
Copper	Strontium
Cobalt	Vanadium
Iron	Zinc

Table 1-5. Soil Sampling Analytes (100-H)

Metals		Radionuclides
Antimony	Magnesium	Strontium-90
Barium	Manganese	Total alpha
Beryllium	Potassium	Total beta
Cadmium	Nickel	Uranium
Chromium (hexavalent)	Sodium	Technetium-99
Chromium (total)	Silver	
Copper	Strontium	**Other**
Cobalt	Vanadium	Fluoride
Iron	Zinc	Nitrate

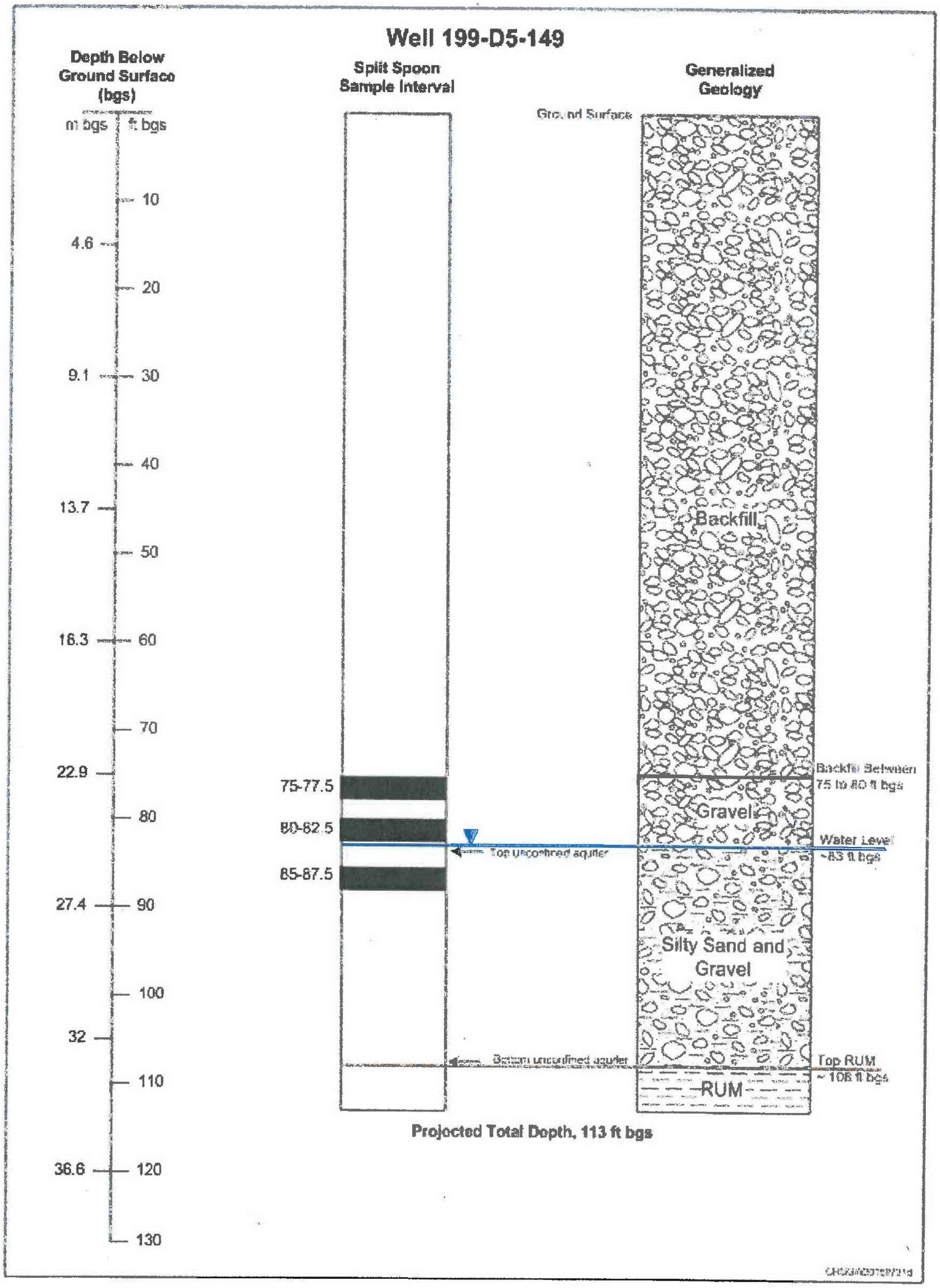


Figure 1-4. Generalized Geology and Approximate Soil Sample Locations – Well 199-D5-149

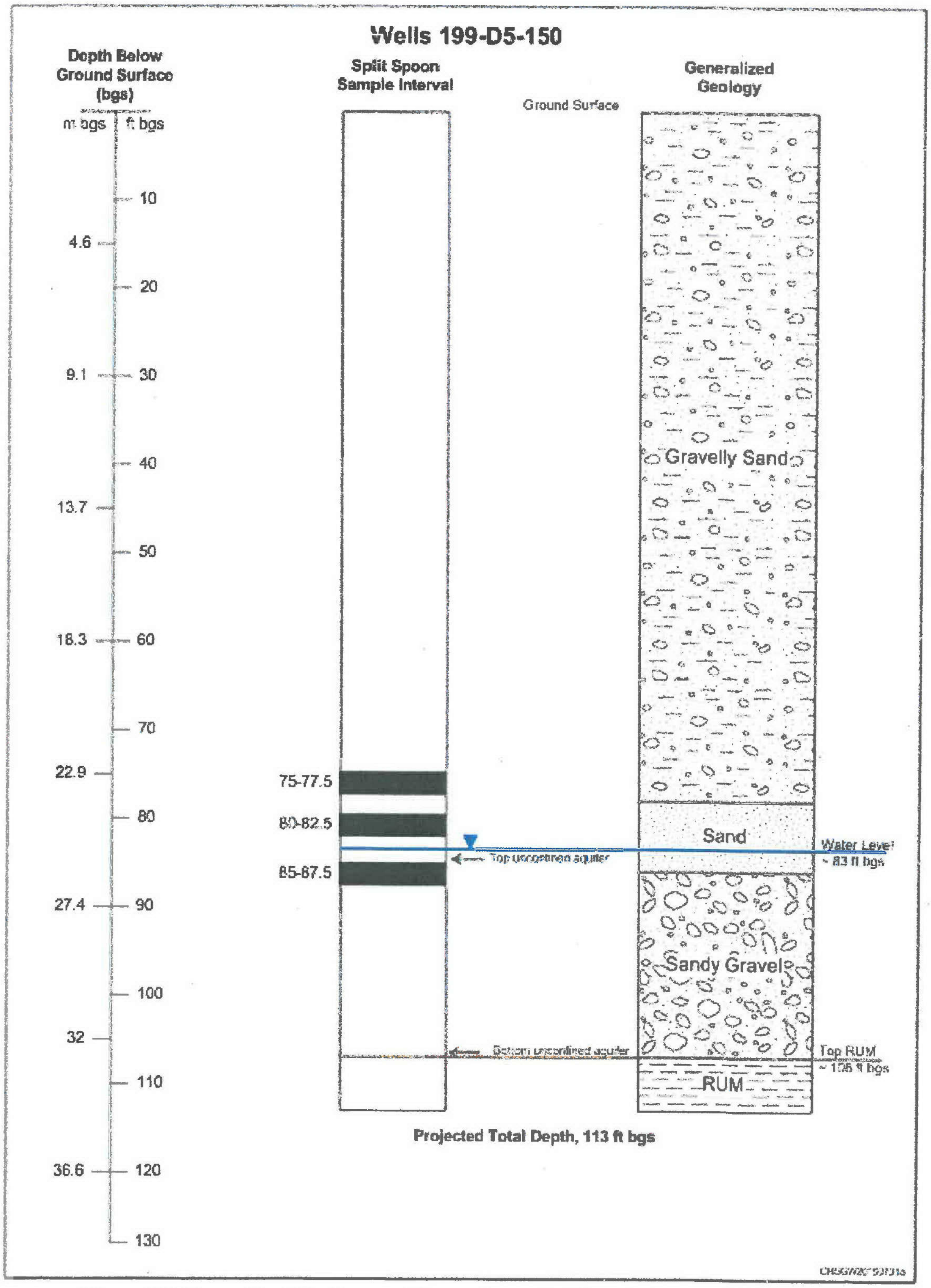


Figure 1-5. Generalized Geology and Approximate Soil Sample Locations – Well 199-D5-150

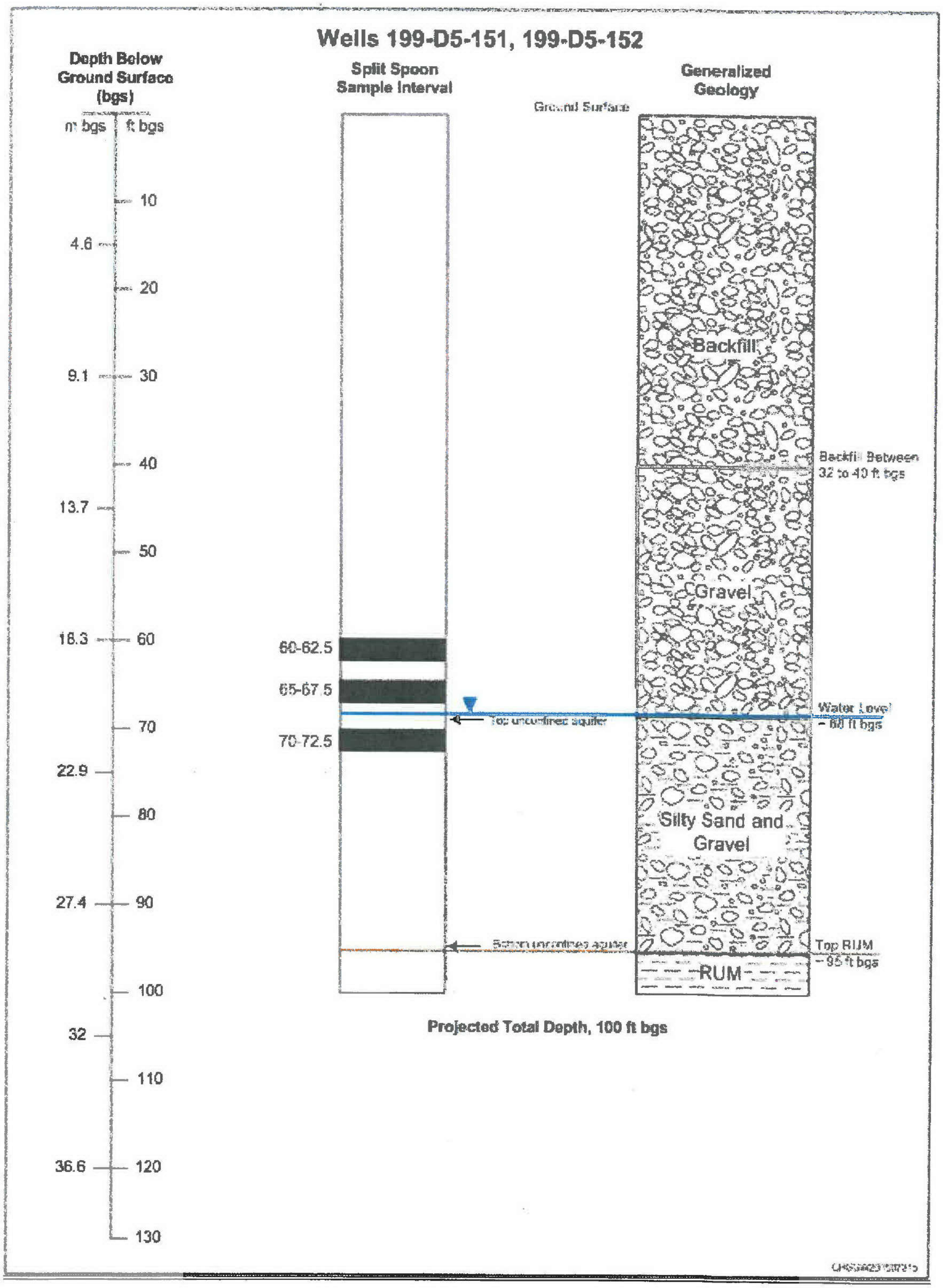


Figure 1-6. Generalized Geology and Approximate Soil Sample Locations – Well 199-D5-151, 199-D5-152

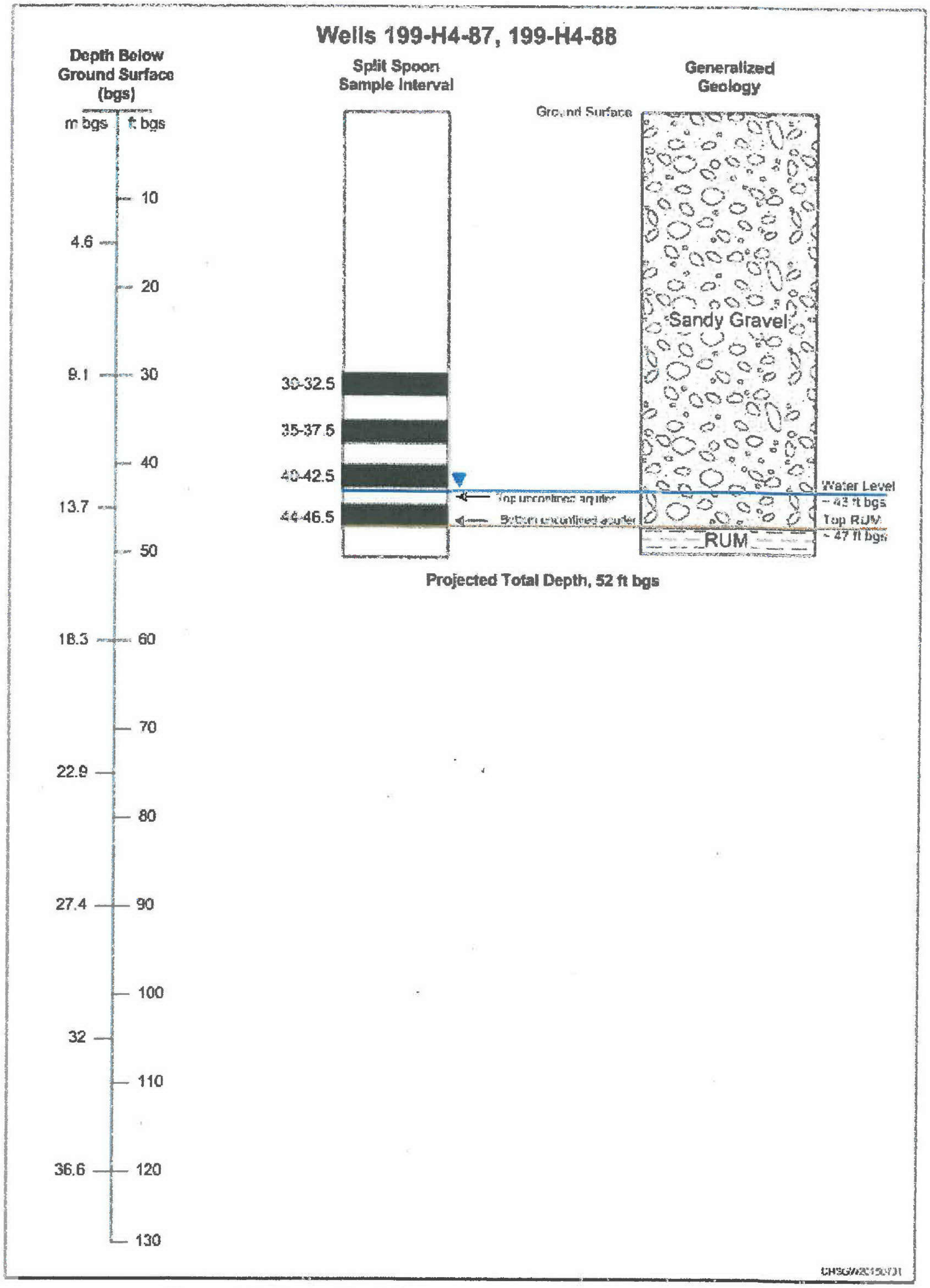
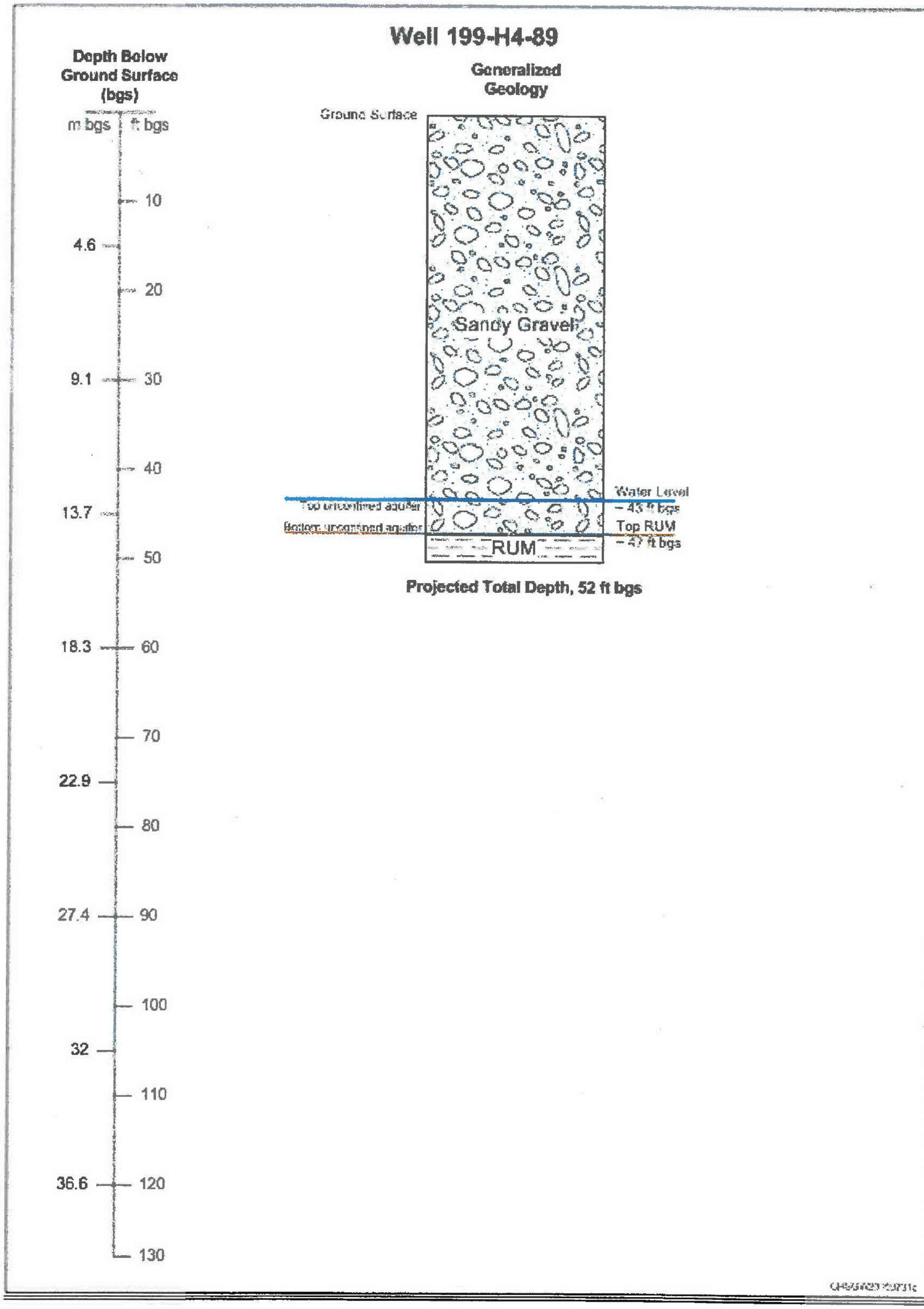


Figure 1-7. Generalized Geology and Approximate Soil Sample Locations – Wells 199-H4-87 and 199-H4-88



Note: Split spoon samples are not planned for this well.

Figure 1-8. Generalized Geology– Well 199-H4-89

Table 2-1. Change Control

Type of Change	Action	Documentation
Temporarily (≤ 1 year) adding constituents, wells, or increasing sampling frequency	OU project management approval; notify regulator.	Project's schedule tracking system
Permanently (>1 year) adding or eliminating constituents, wells, or increasing/decreasing sampling frequency	Revise SAP (or Tri-Party Agreement Change Notice, if appropriate); obtain DOE and regulatory approval; distribute plan.	Letter report documenting changes or revised plan (or approved Tri-Party Agreement Change Notice)

2.2 Data Generation and Acquisition

The following subsections present the requirements for sampling methods, sample handling and custody, analytical methods, and field and laboratory QC. The requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed. The sampling design is presented in Section 3 of this SAP.

2.2.1 Sample Collection, Preservation, Containers, and Holding Times

The requirements for aquifer sediment sieve analysis are listed in Table 2-2. Suggested sample container, preservation, and holding time requirements are specified in Table 2-3 for groundwater samples. Suggested sample container, preservation, and holding time requirements are specified in Table 2-4 for soil samples. These requirements are in accordance with the analytical method specified. The final container type and volumes will be identified on the sampling authorization form and the chain-of-custody form. This SAP defines a "sample" as a filled sample bottle for starting the clock for holding-time restrictions.

Table 2-2. Aquifer Sediment Sieve Analysis Requirements

Method Name	Number of Bottles	Bottle Type	Volume (gram)	Preservation Required	Holding Time
Grain-size distribution (field sieve analysis) in accordance with ASTM D422-63(2007)	1	G/P	250	None	6 months

Source: American Society for Testing and Materials (ASTM) D422-63(2007), *Standard Test Methods for Particle-Size Analysis of Soils.*

Table 2-3. Sample Container, Preservation, and Holding Time Guidelines for Groundwater Samples by Analytical Method

Method Name	Number of Bottles	Bottle Type	Volume (mL)	Preservation Requirement	Holding Time
Strontium-90 CS/GPC or LSC	1	G/P	1,000	HNO_3 to pH <2	6 months
EPA 200.8 – ICP/MS	1	G/P	250	HNO_3 to pH <2	6 months

Table 2-3. Sample Container, Preservation, and Holding Time Guidelines for Groundwater Samples by Analytical Method

Method Name	Number of Bottles	Bottle Type	Volume (mL)	Preservation Requirement	Holding Time
EPA 6010 – ICP	1	G/P	250	HNO_3 to pH<2	6 months
EPA 7196	1	G/P	250	Cool 4°C	~~30 days~~24 hours
IC anions 300.0	1	P	120	Cool 4°C	28 days/ 48 hours[a]
Standard Method 2320 - Alkalinity	1	G/P	250	Cool 4°C	14 days

a. The EPA Method 300.0 nitrate, nitrite, and phosphate holding time is 48 hours after sample collection. The holding time of 28 days applies to all other anions quantified by EPA Method 300.0.

Source: For EPA Method 200.8, see EPA-600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1.*

For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes.*

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, 3rd Edition; Final Update IV-B.*

For Standard Method 2320, see *Standard Methods for the Examination of Water and Wastewater, 22nd Edition.*

CS = chemical separation
LSC = Liquid Scintillation Counting
EPA = U.S. Environmental Protection Agency
G = glass
GPC = Gas Proportional Counting
IC = ion chromatography
ICP = inductively coupled plasma
MS = mass spectroscopy
P = plastic

Table 2-4. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method Name	Number of Bottles	Bottle Type	Volume (g)	Preservation Requirement	Holding Time
Strontium-90 CS/GPC or LSC	1	G/P	20	None	6 months
Gross Alpha/Gross Beta GPC	1	G/P	60	None	6 months
Technitium-99 LSC	1	G/P	60	None	6 months
EPA 6020 – ICP/MS	1	G/P	120	None	6 months
EPA 6010 - ICP	1	G/P	120	None	6 months

Table 2-4. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method Name	Number of Bottles	Bottle Type	Volume (g)	Preservation Requirement	Holding Time
IC anions 300.0	1	G/P	120	Cool 4°C	28 days/48 hours[a]

a. The EPA Method 300.0 nitrate, nitrite, and phosphate holding time is 48 hours after sample extraction preparation. The holding time of 28 days applies to all other anions quantified by EPA Method 300.0

For EPA Method 300.0 see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes.*

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Soil Waste: Physical/Chemical Methods, 3rd Edition; Final Update IV-B.*

CS = chemical separation

LSC = Liquid Scintillation Counting

EPA = U.S. Environmental Protection Agency

G = glass

GPC = Gas Proportional Counting

IC = ion chromatography

ICP = inductively coupled plasma

MS = mass spectroscopy

P = plastic

2.2.2 Sampling Methods Requirements

The procedures to be implemented in the field should be in accordance with those presented in Section 3.3 of this SAP.

2.2.3 Sampling Identification

A sample and data tracking database will be used to track the samples from the point of collection through the laboratory analysis process. The HEIS database is the repository for laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project, and the numbers are to be carried through the laboratory data-tracking system.

2.2.4 Sample Handling, Shipping, and Custody Requirements

The processes followed for sample handling, shipping, and custody requirements will be in accordance with those presented in Section 3.3 of this SAP.

2.2.5 Laboratory Sample Custody

Sample custody during laboratory analysis will be addressed in the applicable laboratory's standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process.

2.2.6 Analytical Methods Requirements

Analytical parameters and methods are presented in Table 2-45 for groundwater samples. Analytical parameters and methods are presented in Table 2-6 for soil samples. Laboratory analysis should be conducted within allowable sample holding times for each analyte tested. Analyses for metals should be performed on unfiltered groundwater samples. This information will be carried through sample and data tracking.

Table 2-45. Analytical Performance Requirements for Groundwater Samples

Class	Analyte[a]	Analytical Method[b]	Detection Limit[c]	Accuracy Requirement (%)	Precision Requirement (%)
RAD	Gross alpha	GPC	3	70-130[g]	≤30[g]
RAD	Gross beta	GPC	4	70-130[g]	≤30[g]

a. The groundwater analytes list is from Table 1-2.

b. Analytical method selection is based on available methods by laboratories currently contracted to the Hanford Site. However, equivalent methods may be substituted.
For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes.*
For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

c. Units are in "pCi/L" for radionuclides or "µg/L" for nonradionuclides. The specified detection limit or minimum detectable concentrations are based on current Hanford laboratory contracts.

d. The accuracy criterion shown is the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criterion shown is for batch laboratory replicate matrix spike analysis relative percent differences.

e. Reported sample Method Detection Limits will be used as a limit of detectability.

f. Reported as total radioactive strontium

g. For radionuclides, the accuracy criterion shown is for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criterion shown is for batch laboratory replicate sample relative percent differences.

CS/LS	=	chemical separation/liquid scintillation
EPA	=	U.S. Environmental Protection Agency
GEA	=	Gamma Energy Analysis
GPC	=	gas proportional counting
IC	=	ion chromatography
ICP/MS	=	inductively coupled plasma/ mass spectrometer
MET	=	metal parameter
RAD	=	radiological parameter

Table 2-6. Analytical Performance Requirements for Soil Samples

Class	Analyte[a]	Analytical Method[b]	Detection Limit[c]	Accuracy Requirement (%)	Precision Requirement (%)
		Nonradionuclides			
MET	Antimony	EPA 6020 or 6010 (ICP/MS or ICP)	1.2	70-130[d]	≤30[d]
MET	Barium		2	70-130[d]	≤30[d]
MET	Beryllium		0.5	70-130[d]	≤30[d]
MET	Cadmium		0.5	70-130[d]	≤30[d]

Table 2-6. Analytical Performance Requirements for Soil Samples

Class	Analyte[a]	Analytical Method[b]	Detection Limit[c]	Accuracy Requirement (%)	Precision Requirement (%)
MET	Chromium (total)		1.0	70-130[d]	≤30[d]
MET	Copper		0.8	70-130[d]	≤30[d]
MET	Cobalt		2.0	70-130[d]	≤30[d]
MET	Iron		5.0	70-130[d]	≤30[d]
MET	Magnesium		75	70-130[d]	≤30[d]
MET	Manganese		5.0	70-130[d]	≤30[d]
MET	Potassium		400	70-130[d]	≤30[d]
MET	Nickel		4.0	70-130[d]	≤30[d]
MET	Sodium		50	70-130[d]	≤30[d]
MET	Silver		1.0	70-130[d]	≤30[d]
MET	Strontium		1.0	70-130[d]	≤30[d]
MET	Uranium		1.5	70-130[d]	≤30[d]
MET	Vanadium		2.5	70-130[d]	≤30[d]
MET	Zinc		1.0	70-130[d]	≤30[d]
MET	Chromium (hexavalent)	EPA 7196	0.5	70-130[d]	≤30[d]
Anion	Fluoride	EPA IC 300.0	25	70-130[d]	≤30[d]
Anion	Nitrate		12.5	70-130[d]	≤30[d]
		Radionuclides			
RAD	Strontium-90[e]	SR-90 GPC or LSC	1	70-130[f]	≤30[f]
RAD	Gross alpha	GPC	5	70-130[f]	≤30[f]
RAD	Gross beta	GPC	10	70-130[f]	≤30[f]
RAD	Technetium-99	LSC	1.5	70-130[f]	≤30[f]

a. The soil analytes list is from Table 1-3 and Table 1-4.

b. Analytical method selection is based on available methods by laboratories currently contracted to the Hanford Site. However, equivalent methods may be substituted.

For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes.*

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition: Final Update IV-B.*

c. Units are in "pCi/g" for radionuclides or "mg/kg" for nonradionuclides. The specified detection limit or minimum detectable concentrations are based on current Hanford laboratory contracts.

Table 2-6. Analytical Performance Requirements for Soil Samples

Class	Analyte[a]	Analytical Method[b]	Detection Limit[c]	Accuracy Requirement (%)	Precision Requirement (%)

d. The accuracy criterion shown is the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criterion shown is for batch laboratory replicate matrix spike analysis relative percent differences.

e. Reported as total radioactive strontium.

f. For radionuclides, the accuracy criterion shown is for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criterion shown is for batch laboratory replicate sample relative percent differences.

LS = Liquid scintillation

EPA = U.S. Environmental Protection Agency

GPC = gas proportional counting

IC = ion chromatography

ICP/MS = inductively coupled plasma/mass spectrometer

MET = metal parameter

RAD = radiological parameter

2.2.7 Quality Control Requirements

Samples for QC are not required for project soil samples that are tested solely for physical properties. QC samples discussed are for groundwater and soil samples. Trip, equipment, and transfer blank QC samples address sample contamination that does not pertain to physical property analyses. Duplicate QC samples pertain to variability of analysis that is not expected to be significant due to the large size of physical property samples. No QC samples are required for the archived geologic samples.

Field QC samples will be collected during groundwater and soil sampling to evaluate the potential for cross-contamination and laboratory performance to help ensure that reliable data are obtained. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

Table 2-~~5~~7 identifies the field QC samples for groundwater and soil sampling. For groundwater samples, one duplicate and one trip blank will be collected from one well in the 100-D Area and one well in the 100-H Area. This number of QC samples is conservatively established based on site procedures that call for approximately one set of QC samples per 20 sampling well trips, with each well representing one sampling well trip. For soil samples, one field duplicate and one trip blank will be collected. The soil will be collected and homogenized before dividing into two separate samples in the field (soil and duplicate).

Table 2-~~5~~7. Field Quality Control Requirements

Sample Type	Frequency	Purpose
Field duplicate	Minimum of 1 sample in 20, per media sampled	To determine precision for both sampling and laboratory measurements
Equipment rinsates blanks	As needed or 1 sample in 20, per media sampled. If only disposable equipment is used, then an equipment rinsate blank is not required.	To verify adequacy of sampling equipment decontamination
Trip blank	Minimum of 1 sample in 20, per media sampled. But at least one for 100-D and one for 100-H	1. To assess contamination from containers or transportation.

2.2.7.1 Field Replicates

Field replicates will be collected at a frequency of one in 20 samples, and at least one per well. Field replicates are used to evaluate laboratory consistency and the precision of field sampling methods.

2.2.7.2 Equipment Rinsates Blanks

Equipment blanks are collected from reusable sampling devices on a 1-in-20 basis, and at least one per well. The drilling leader may request additional equipment blanks be taken. Equipment blanks will consist of silica sand or analyte-free water poured over the decontaminated sampling equipment and placed in containers. Equipment blanks are not needed for disposable sampling equipment.

2.2.7.3 Trip Blanks

Trip blanks are prepared by the sampling team prior to traveling to the sampling site. The preserved bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. It is filled with reagent water or silica sand, as appropriate to the primary sample media. The bottles are sealed and will be transported, unopened, to the field in the same storage containers used for samples collected the same day. The trip blanks are typically analyzed for the same constituents as the samples from the associated sampling event. Trip blanks are used to evaluate potential contamination of the samples attributable to the sample bottles, preservative, handling, storage, and transportation.

2.2.8 Measurement Equipment

Each user of the measuring equipment is responsible to ensure the equipment is functioning as expected, properly handled, and is calibrated before expiration in accordance with procedures governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance shall be recorded in a bound logbook (see Section 3.4.3). Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved procedures.

2.2.8.1 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Onsite environmental instruments shall be tested, inspected, and maintained. Measurement equipment must be inspected before use. Maintenance requirements (e.g., parts lists and documentation of routine maintenance) will be included in the individual laboratory's and onsite organization's QA plan and/or

3 Field Sampling Plan

This field sampling plan identifies activities for installation of new groundwater wells, soil sampling during borehole installation, groundwater sampling following completion of well development, and groundwater sampling following well acceptance. This SAP provides for soil and groundwater sampling to meet the defined sampling objectives.

3.1 Sampling Objectives

The soil and groundwater sampling objectives were identified by the project team during the sample planning process, and reviewed by Ecology. The objectives of the sampling are to confirm the lithology, assist in well design, collect lithologic samples to meet potential future needs, determine if contamination is present in the periodically rewetted zone, and determine groundwater contaminant level. Groundwater samples collected during drilling are to be collected to determine the vertical distribution in contaminant levels. Data will be compared with analytical results from the excavations and from nearby wells.

Lithology will be described and documented during the drilling of each well. Aquifer sediment will be collected from the upper and lower portions of the aquifer to design the filter pack and corresponding well screen. Archive samples will be obtained at 1.5 m (5 ft) intervals and at major lithologic changes. Soil sampling will be conducted to determine if contamination is present in the periodically rewetted zone. Since contamination is anticipated to be present within the periodically rewetted zone in several boreholes, sampling will target low river stage and be focused within the periodically rewetted zone and upper aquifer based on seasonal water table variations in the area (Figures 1-4, 1-5, and 1-6). Groundwater sampling is conducted to define the magnitude and extent of hexavalent chromium contamination in the aquifer and at select locations to track groundwater chemistry near areas of source remediation, as well as the vertical distribution of contamination in 100-D.

3.2 Sampling Design

To meet project sampling objectives, the sampling design identifies the sampling locations, sample intervals, sample processes, target analytes and parameters, and analytical methods. The key features of soil and groundwater sampling design and the sampling rationale are summarized in Table 3-1.

Table 3-1. Key Features of Project Sampling Design

Analytical Methodology	Key Features of Design	Sampling Design Rationale
	Geologic Samples for Archiving	
Geological sampling	**Specific location/area of concern**: The boreholes requiring geologic sampling are located as shown in Figures 1-2 and 1-3. The soil of concern for geologic sampling range from 1.5 m (5 ft) bgs to total borehole depth. **Investigation method**: Geologic samples will be taken beginning at a depth of 1.5 m (5 ft) bgs and continuing at 1.5 m (5-ft) intervals and at major lithologic changes to total borehole depth. **Analytes**: These samples will be archived for possible future analysis, and target analytes would be determined based on data needs identified at that time. If contamination is identified or suspected during drilling, the drilling lead and/or OU Project manager may request analysis for specific analytes.	Geologic samples will be archived in case future data needs are identified. Laboratory analysis may be requested if contamination is identified or suspected during drilling.

Table 3-1. Key Features of Project Sampling Design

Analytical Methodology	Key Features of Design	Sampling Design Rationale
	Geologic Aquifer Soil Samples	
Geological sampling	**Specific location/area of concern**: The soils of the unconfined aquifer are of interest to this investigation. **Investigation method**: Aquifer soil will be investigated by collection of one geologic sample from soil of the upper portion of the aquifer and one sample from soil of the lower portion of the aquifer. **Analytes**: The aquifer soil samples will be tested for the physical property of grain-size distribution (sieve analysis) (Table 2-2).	Soil physical property data are necessary to facilitate well design to maximize well efficiency.
	Soil Samples	
Soil Sampling	**Specific location/area of concern:** The soil in the periodically rewetted zone at Well 199-D5-149, 199-D5-150, 199-D5-151, 199-D5-152, 199-H4-87, and 199-H4-88 are of interest to this investigation. **Investigation method:** Soil will be investigated by collecting three or four samples from each borehole as shown in Figures 1-4 through 1-8. The deepest sample is to be collected from approximately 5 ft into the aquifer. **Analytes:** The aquifer soil samples will be tested for the analytes listed in Table 1-4 and 1-5 for those wells at 100-D and 100-H, respectively.	To determine if contamination is present in the periodically rewetted zone.
	Groundwater Sampling During Drilling	
Groundwater sampling	**Specific location/area of concern:** The groundwater at each location is of concern. **Investigation method:** Three water samples will be collected during drilling at wells 199-D5-149, 199-D5-150, 199-D5-151, and 199-D5-152. Approximate depths for water samples are listed in Table 1-3. **Analytes:** Hexavalent Chromium	Determine hexavalent chromium concentrations vertically within the aquifer.
	Groundwater Sampling During Well Development	
Groundwater sampling	**Specific location/area of concern**: The groundwater at each location is of concern. **Investigation method**: One groundwater sample will be collected from each well location upon completion of well development. **Analytes**: Hexavalent Chromium	Confirm well use and the ambient chromium concentrations that will be used to confirm chromium concentration within the aquifer.

Table 3-1. Key Features of Project Sampling Design

Analytical Methodology	Key Features of Design	Sampling Design Rationale
	Groundwater Sampling Post Well Acceptance	
Groundwater sampling	**Specific location/area of concern**: The groundwater near source site remediation. **Investigation method**: Groundwater samples will be collected from wells as described in Table 3-3. **Analytes**: Table 1-2 identifies the list of groundwater analytes.	Determine and track contaminant concentrations at identified wells during source remediation activities and monitor groundwater plumes.

bgs = below ground surface

3.2.1 Borehole Drilling

Boreholes for the new groundwater wells will be drilled through the upper unconfined aquifer of the 100-D and 100-H Areas to a depth ~~at least~~ of approximately 1.5 m (5 ft) into the RUM. Well locations are shown in Figures 1-2 and 1-3. The penetration into the RUM may be less, depending on the competence of the material encountered. Given the variability of depth to groundwater in the 100-D and 100-H Areas, the aquifer thickness, and the 1.5 m (5-ft) penetration into the RUM, total borehole depths at the 100-D Area could vary from approximately 14 to 30 m (46 to 98 ft) and at the 100-H Area from approximately 14 to 16 m (46 to 52 ft).

3.2.2 Well Installation and Development

Well drilling and completion will be performed in accordance with the requirements of WAC 173-160. If the completion differs from the WAC 173-160 requirements, then variances will be obtained from Ecology.

The wells will be constructed generally (as shown in Figure 3-1) using 15.2 cm (6-in.) diameter (or larger) casing. The drilling method will be determined by the drilling lead and drilling contractor. The wells will be built with Schedule 10, Type 304 or 316, stainless steel, V-slot, continuous wire-wrap screen, on top of a 0.9 m (3-ft) long, stainless steel sump with end cap. The screen will fully penetrate the aquifer and the top of the screen will be set above the high water level mark. At 100-H wells, the wells will be drilled to a depth adequate to ensure pump operations during low water periods. A schedule 10 stainless steel casing will extend from the top of the well screen to the ground surface. Colorado silica sand or approved equivalent will be used for the sand pack; sodium bentonite pellets and/or natural sodium bentonite chunks, crumbles, or powdered bentonite will be used for bentonite sealing material; and Type I/II Portland cement will be used for cement grout.

Surface construction will consist of a protective casing, protective guard posts, and cement pad. The protective casing shall be a minimum of 5.1 cm (2 in.) larger in diameter than the permanent casing. Protective casing shall rise approximately 0.9 m (3 ft) above the ground surface. Permanent casing shall rise to approximately 0.3 m (1 ft) below the top of the protective casing. Protective casing shall have a lockable well cap extending approximately 38 cm (15 in.) above the top of the protective casing.

3.3 Sampling Locations and Frequencies

Boreholes will be drilled through the unconfined aquifer and at least 1.5 m (5 ft) into the RUM. Figures 1-2 and 1-3 show the approximate well installation locations. The actual well locations could vary, slightly based on a field walkdown of current site conditions in order to avoid Hanford Site National Historic Monument restrictions, roads, and other obstructions. Table 3-2 shows sample collection during drilling. Table 3-3 shows groundwater sample collection after well acceptance.

3.3.1 Soil Sample Locations and Frequencies

During borehole installation, geologic samples will be collected for archiving beginning at 1.5 m (5 ft) bgs and continuing at 1.5 m (5-ft) intervals and at major lithologic changes to total borehole depth. Based on known geologic conditions, it is estimated that 25 samples will be collected at each 100-D well, and 15 at each 100-H well. However, this is subject to change based on conditions encountered during drilling. Additional samples may be required. Figures ~~3-2 and 3-3 are generalized~~ 1-4, 1-5, 1-6, and 1-7 include borehole schematics that identify soil sampling intervals at the 100-D and 100-H Area boreholes. Split spoon samples are not planned for Well 199-H4-89, as shown in Figure 1-8. Soil sample locations will be adjusted to account for water table fluctuation based on time of drilling the well, as determined by nearby wells, with the deepest sample location targeting a depth of 1.5 m (5 ft) into the aquifer.

During installation of Wells 199-D5-149, 199-D5-150, 199-D5-151, 199-D5-152, 199-H4-87 and Well 199-H4-88, soil samples will be collected for analysis from the approximate depths shown on Figures 1-4 through 1-7. Actual depths for soil samples will depend on conditions encountered during drilling.

3.3.2 Groundwater Sample Locations and Frequencies

During borehole installation, three water samples will be collected at each of the following Wells: 199-D5-149, 199-D5-150, 199-D5-151, and 199-D5-152. Groundwater samples are to be collected approximately 5 feet into the aquifer, at approximately 10 to 15 feet into the aquifer, and at the RUM interface at approximately 22 to 25 feet into the aquifer.

One groundwater sample will be collected from the aquifer at each well location following the completion of well development. Groundwater samples during development are summarized in Table 3-2. Groundwater samples to be collected post well acceptance are summarized in Table 3-3. Analytes for groundwater are given in Table 1-2. For those samples collected on an annual basis, the goal is to conduct the annual sampling event in a single month and at the lowest river stage.

3.4 Field-Specific Collection Requirements

Field specific collections requirements are outlined in the following sections.

Table 3-2. Summary of 100-HR-3 Well Sample Collection Requirements During Drilling

Sample Type	Sample Collection Method	Sample Depth Intervals	No. of Samples Estimated	No. of Quality Control Samples	Analytical Requirements and Parameters
100-D Area Wells as Identified on Table 1-1 (per well)					
Soil (archive)	Grab	1.5 m (5 ft)	25[a]	0	N/A
Soil (sieve)	Grab	~~See Figure 3-2~~ 27 and 30 m (90 and 100 ft): Wells 199-D5-149 and 199-D5-150 24 and 27 m (80 and 90 ft): Wells 199-D5-151 and 199-D5-152	2	0	N/A
Soil	Split-spoon	See Figure 1-4, 1-5 and 1-6	3	2	Hexavalent chromium and Metals
Groundwater	Pump	Well	~~1[b]~~ 4[b,c]	2[b,d]	Hexavalent chromium
100-H Area Wells as Identified on Table 1-1 (per well)					
Soil (archive)	Grab	1.5 m (5 ft)	15[a]	0	N/A
Soil (sieve)	Grab	~~See Figure 3-3~~ 13 and 14.3 m (43 and 47 ft)	2	0	N/A
Soil	Split-spoon	See Figure 1-7	4	2	Metals, Hexavalent chromium, Fluoride, Nitrate, Sr-90, Total Alpha/beta, Tc-99, total uranium
Groundwater	Pump	Well	1[b,c]	2[d]	Hexavalent chromium

Sample Type	Total number of Analytical Samples	Total number of Quality Control Samples	Total Samples
Soil (archive)	--[e]	--	--
Soil (sieve)	--f	--	--
Soil	24	4	28
Groundwater	~~13~~ 19	4[g]	~~17~~ 23

Table 3-2. Summary of 100-HR-3 Well Sample Collection Requirements During Drilling

a. Based on a total depth of 30 m (100ft) or 33.5 m (110 ft) for 100-D and 18.3 m (60 ft) for 100-H. The actual depth drilled will depend on conditions found.

b. Three water samples will be collected during drilling at 100-D. Groundwater samples are to be collected during drilling at approximately 5 feet into the aquifer, at approximately 10 to 15 feet into the aquifer, and at the RUM interface, approximately 22 to 25 feet into the aquifer.

c. One groundwater sample will be collected from each well following completion of well development.

d. Groundwater QC samples, composed of one duplicate and one equipment blank, will be collected after well development from one replacement well in the 100-D Area and one well in the 100-H Area for a total of four groundwater QC samples.

e. No archive samples are to be analyzed, but are to be held for later analysis if needed.

f. Sieve analysis is done in the field.

g. Number adjusted for each drilling campaign.

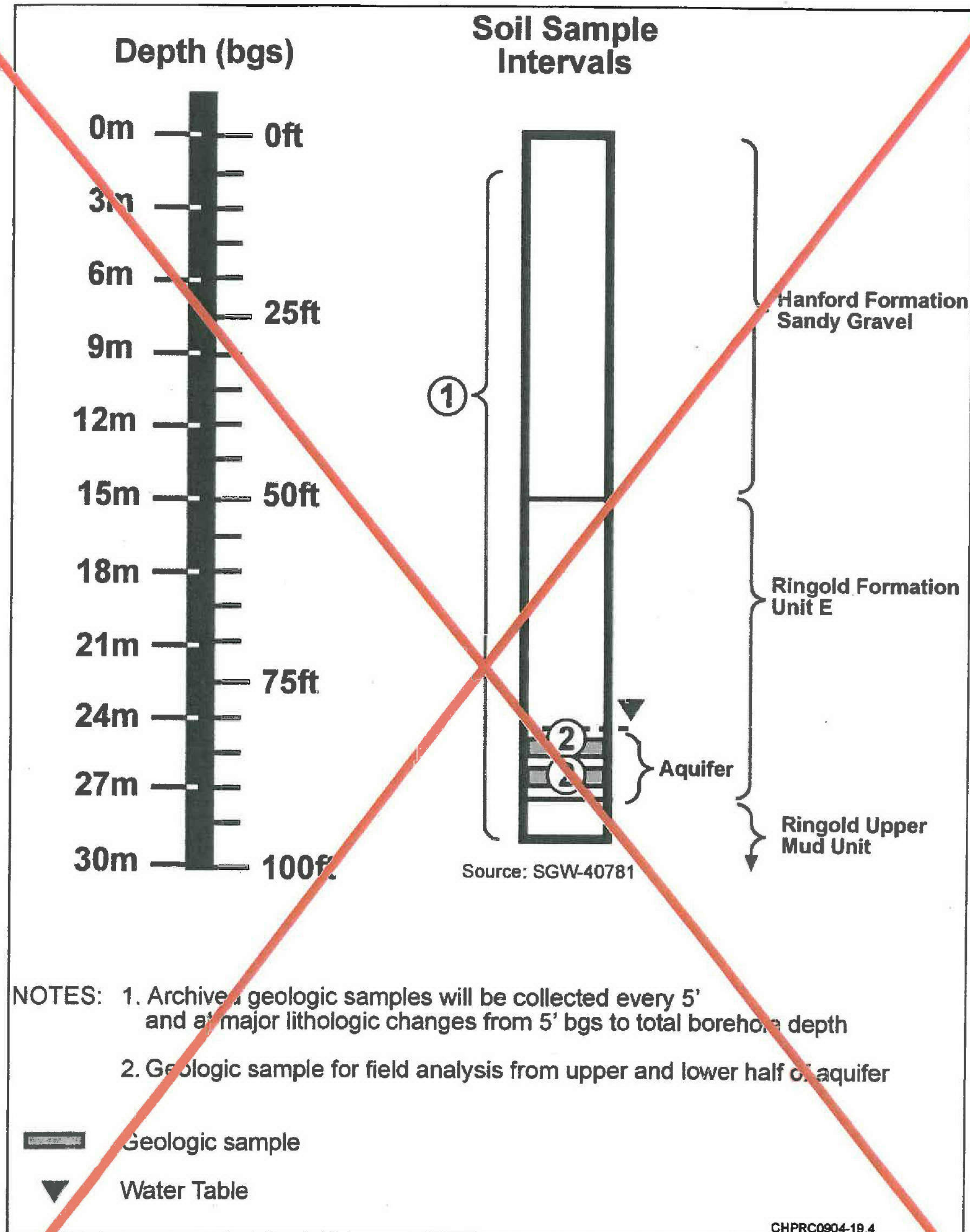
Table 3-3. Analytical Methods and Frequency for Post Well Acceptance Groundwater Samples

Replacement Well	Field Parameters	Alkalinity	Anions	Gross Alpha	Gross Beta	Hexavalent Chromium*	Metals*	Strontium-90	Comment
199-H4-86	A	A	A	A	A	A	A	A	~~Injection Well~~ Extraction Well
199-H4-85	M	M	M	A	A	M	M	A	Well sampled under RCRA
199-D5-145	M	M	M	A	A	M	M	A	Well sampled monthly for 1 year
199-D5-146	M	M	M	A	A	M	M	A	Well sampled monthly for 1 year
199-D5-147	M	M	M	A	A	M	M	A	Well sampled monthly for 1 year
199-D5-148	A	A	A	A	A	A	A	A	Injection Well
199-D5-149	Q	A	A	A	A	Q	A	A	
199-D5-150	A	A	A	A	A	~~A~~Q	A	A	
199-D5-151	M	M	M	A	A	M	M	A	Well sampled monthly for 1 year
199-D5-152	M	M	M	A	A	M	M	A	Well sampled monthly for 1 year
199-H4-87	Q	A	A	A	A	Q	A	A	
199-H4-88	M	M	M	A	A	M	M	A	Well sampled monthly for 1 year
199-H4-89	A	A	A	A	A	A	A	A	

Note: Alkalinity will also be analyzed. Filtered and unfiltered samples

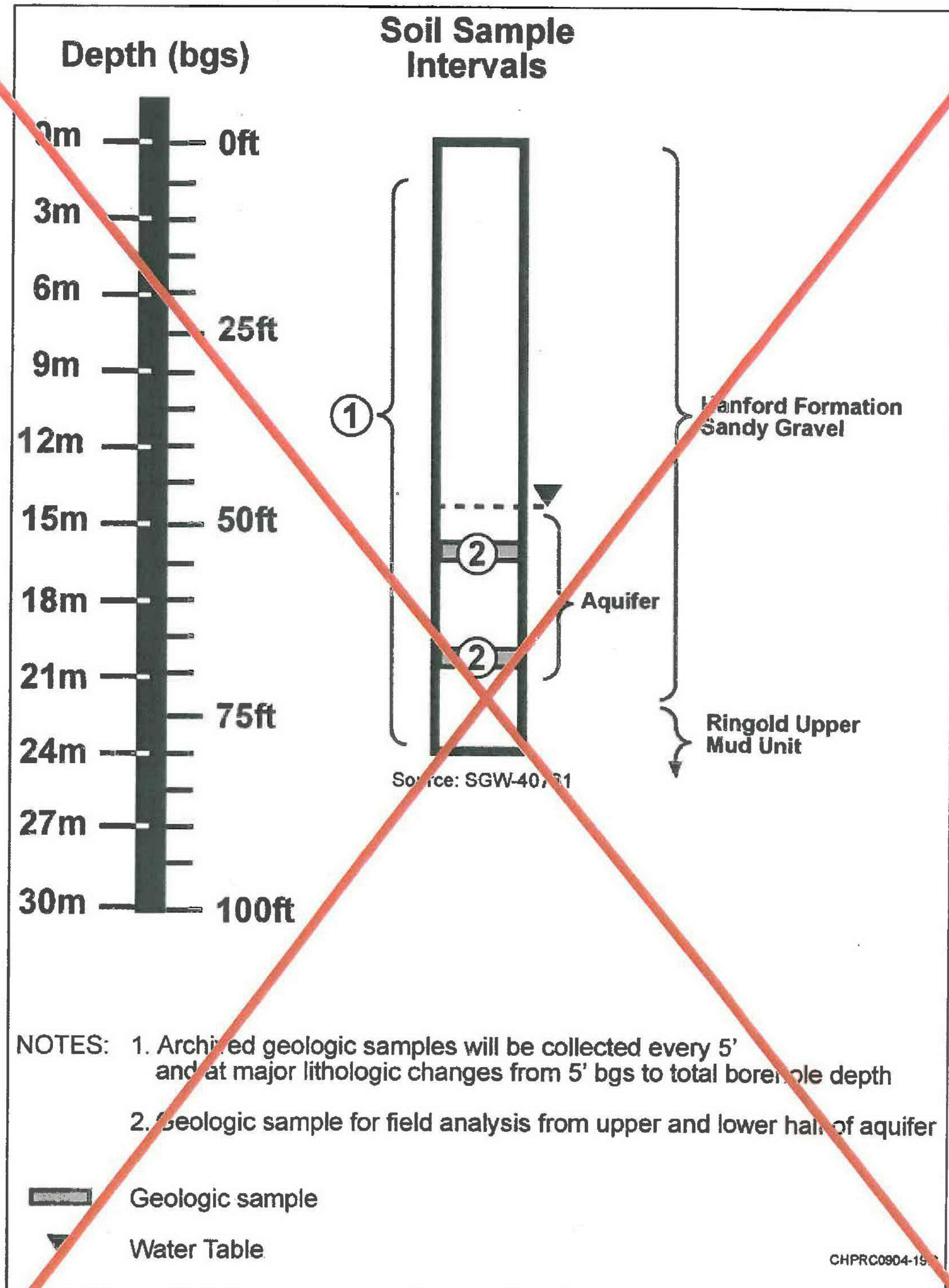
* Filtered and unfiltered samples

A = annual; Q = quarterly; M = monthly



~~Source: SGW-40781, 100-HR-3 Remedial Process Optimization Data Package.~~

~~**Figure 3-2. Intervals for 100-D Area Replacement Wells**~~



~~Source: SGW-40781, 100-HR-3 Remedial Process Optimization Data Package.~~

~~**Figure 3-3. Intervals for 100-H Area Replacement Wells**~~

3.4.2 Sample Identification

A sample tracking database will be used to track the groundwater and soil samples through the collection and laboratory analysis process. The HEIS database is the repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook. Each sample container will be labeled with the following information, using a waterproof marker on firmly affixed, water-resistant labels:

- Sampling authorization form number
- Chain-of-custody identification number
- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable)

3.4.3 Field Sample Logbook

Information pertinent to sampling and analysis will be recorded in field checklists and logbooks in accordance with existing sample collection protocols. The sampling team will be responsible for recording relevant sampling information (e.g. wind direction, sample color). Entries made in the logbook will be dated and signed by the individual making the entry. Program requirements for managing the generation, identification, transfer, protection, storage, retention, retrieval, and disposition of records will be followed.

3.4.4 Sample Custody

Sample custody will be maintained in accordance with existing Hanford Site protocols. The custody of samples will be maintained from the time that samples are collected until ultimate disposal of the samples, as appropriate. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to the laboratory. Sample shipping procedures will be followed throughout sample shipment. Each chain-of-custody form will include the sample identification number, associated well identification number, and remediation system designation. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form.

Chain-of-custody procedures will be followed throughout sample collection, storage, transfer, analysis, and disposal to ensure that sample integrity and traceability are maintained. Each time the responsibility for the custody of the sample changes, the new and previous custodians will sign the record and note the date and time. A custody seal (i.e., evidence tape) will be affixed to the lid of each sample jar. The container seal will be inscribed with the sampler's initials and the date. Sample custody during laboratory analysis will be addressed in the applicable laboratory's standard operating procedures.

3.4.5 Sample Shipping

Samples will be transported after authorization from the Soil & Groundwater Remediation Project (S&GRP)-authorized shipper. If the wells have a medium or high risk of encountering radiological material, radiological surveys will be required. If radiological materials are not anticipated, RCT surveys may not be required if the RCT field readings show no activity above background. As applicable, the RCT will measure the radioactive contamination levels on the outside of each sample jar and the dose rates on each sample jar. As applicable, the RCT will also measure the radiological activity on the outside of the sample container (through the container) and will document the highest contact radiological reading in millirem per hour (mrem/hr). This information, along with other data, will be used to select proper